Environmental Management Technology Demonstration and Commercialization Under the FETC–EERC EM Cooperative Agreement

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I. Introduction

Successful implementation of the Department of Energy (DOE) Environmental Management (EM) Program's 2006 Plan will require the timely deployment of cost-effective, efficient, and safe cleanup technologies within the DOE complex. The Energy & Environmental Research Center (EERC), a nonprofit, contract-supported research, development, demonstration, and commercialization unit of the University of North Dakota, is entering the sixth year of a Cooperative Agreement with the DOE Federal Energy Technology Center (FETC) designed to expedite technology deployment through a combination of services, including technical support, demonstrations, and brokering. This paper profiles select activities under the FETC–EERC EM Cooperative Agreement and details the part the Cooperative Agreement plays in meeting EM goals.

II. FETC–EERC EM Cooperative Agreement: Concept and Approach

Technology commercialization can be hampered by limited capabilities for testing and demonstration, limited capital, and, specific to the EM Program, a limited knowledge of DOE and EM site needs. In other cases, commercial-ization may hinge on the successful resolution of technical issues outside the traditional focus of the technology developer. Deployment of the technology in the highly competitive EM marketplace requires sound data from field tests that clearly demonstrate the superior capabilities of the technology, knowledge of site plans and personnel, and the potential to incorporate the technology into the ongoing site cleanup activities with minimal disruption.

Under the FETC–EERC EM Cooperative Agreement, the EERC is able to provide up to $150,000 annually in services geared toward minimizing commercialization barriers through focused technical assistance, partnership brokering, and demonstrations. In order to accomplish this mission, the EERC continually seeks to match its core capabilities with the needs of promising technologies (i.e., technologies at a minimum of Gate 3 with the potential for wide application within the complex). Once a candidate activity is identified, the EERC works with the technologist to develop a proposal for services, which is submitted for FETC approval.

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Competitive advantage is protected through proven confidentiality agreements.

The EERC features a multidisciplinary staff of over 120 full-time science and engineering professionals and a dedicated 169,000 ft^2 facility, which houses offices as well as a broad range of analytical, testing, and demonstration capabilities. Tests and demonstrations represen-tative of a wide range of conditions can be undertaken at the laboratory to pilot scale. The EERC currently has major programs in mercury control and remediation, water and waste treat-ment, air toxics sampling and control, and site characterization. Systems engineering capabil-ities are also available for performance and costing assessments.

Regulatory constraints and liability concerns can create barriers to field site access for demonstrations. The EERC's growing family of industrial partners provides the potential for access to a wide variety of technology demonstration sites. For example, the EERC has access to a remediation demonstration site in Alberta, Canada, through a relationship with the Canadian Association of Petroleum Producers, Gulf Canada, and the DOE Jointly Sponsored Research Program. Further, the EERC has an established track record for scientifically sound field test design, oversight, and evaluation.

In order to meet the needs of the 2006 Plan, technologies must be successfully deployed at EM sites. Under the Cooperative Agreement, the EERC works as an active partner to understand site issues and technology needs, to support development of the information packages required by client sites for the evaluation and deployment of technologies, and to support deployment-brokering activities.

III. Commercialization Activities

Activities under the Cooperative Agreement are summarized in Table 1.

In 1999, the fifth year of the Cooperative Agreement, the EERC provided services to eight technologists. Work on select tasks active in Year 5 is summarized below.

Task 13 – Cone Penetrometer for Subsurface Heavy Metals Detection. Science and Engineering Associates (SEA), Inc., of Albuquerque, New Mexico, has developed a real-time, in situ, analytical tool for the detection of heavy metals in the subsurface. The tool uses laser induced breakdown spectroscopy (LIBS) and is deployed using a specially designed cone penetrometer (CPT) probe. In the summer of 1997, the LIBS CPT was successfully demonstrated at Sandia National Laboratory (SNL).

The EERC has provided technical assistance to SEA for the LIBS–CPT since 1996. During that period, EERC contributions to the advancement of the LIBS–CPT technology include 1) the assessment of field sites and the retrieval of field soil samples containing metals (i.e., Cr, Pb, As, Cd, Zn, and Cu); 2) calibration of the LIBS instrument using laboratory-prepared calibration samples containing verified concentrations of Cr, Pb, As, Cu, and Zn; 3) in-field technical support and performance assessment for the LIBS–CPT field demonstration at SNL; 4) application of multivariate data analysis techniques to LIBS data, resulting in improved instrument calibrations and sample determination of metals concentration in soils; and 5) exploration of the application of LIBS technology beyond CPT, including the ex situ analysis of soils, the determination of Pb concentrations in surface coatings, and the characterization of metal alloys.

EM Technology	Commercial Partner	Technology Design Modification and Testing (lab-to-full-scale field)	Process Stream and By-Product Sampling, Analysis, Characterization, or Modeling	Technology Demonstration
Automated Laser-Based Units for Removing Contaminated Paints and Surface Coatings	F2 Associates	●	●	
Centrifugal Membrane Filtration for Aqueous Stream Treatment	SpinTek Membrane Systems, Inc.	●	●	★
Fiber-Optic Cone Penetrometer System for Subsurface Metal Detection	Science & Engineering Associates	●		●★
Bubbleless Gas-Transfer Technology for In Situ Bioremediation of Chlorinated Hydrocarbons	Baumgartner Environics Incorporated	●		
Subcritical Water Technology for Treatment of Hydrocarbon-Contaminated Soil	Pending	●	●	●☆
Waste Vitrification Facility	Vortec Corporation		●	●☆
Field SFE and Field SFE/FT-IR for Extraction and Analysis of Organic Pollutants	Suprex Corporation	●	●	●
Acoustic Enhancement of Groundwater Remediation	Weiss Associates	●		
Mercury Removal from Solid Materials	MRS	●	●	
Steam Reforming of Hazardous Materials	ThermoChem		●	
Chlorine Removal from High-Temperature Systems	GTS Duratek	●	●	●☆
Development of an In Situ Instrument for Measuring Mercury in a Gas Stream	Sensor Research & Development Corporation	●	●	
Processing Contaminated Plant Residues	PHYTOkinetics		●	
Integrated Chemical Reaction Kinetics in Contaminated Transport Model	DIAMO	●		

EERC Involvement
● Active or Completed
○ Planned

EM Site Demonstration
★ Active or Completed
☆ Planned

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Table 1. EERC activities under the Cooperative Agreement.

Task 15 – Remediation of Organically Contaminated Soil Using Hot/Liquid (Subcritical) Water. Current remediation technologies for semivolatiles in soil are expensive, time-consuming, and often generate additional wastes. Although liquid water is normally considered too polar a solvent to be effective for the removal of organic contaminants from soils, the EERC has demonstrated that the solvent properties of liquid water can be changed from very polar at ambient conditions to those resembling the behavior of an organic solvent (e.g., ethanol or acetonitrile) by simply raising the temperature. The EERC has exploited this unique property of water in developing a portable field technology that uses subcritical (hot/liquid) water for ex situ soil cleaning. The technology can be used for the removal of organics ranging from polychlorinated biphenyls (PCBs) to polycyclic aromatic hydrocarbons (PAHs) to pesticides and explosives.

Significant accomplishments include 1) the successful pilot-scale remediation, including the restoration of soil fertility, of soils highly contaminated with pesticides and PAHs; 2) the pilot-scale degradation (concentrations reduced from >1 wt% to nondetectable levels) of high explosives (RDX, HMX, and TNT) in soils in a closed subcritical system (no pump required and no contaminated wastewater produced); and lab-scale degradation of high explosives at temperatures as low as 150°C in 15 to 60 minutes.

Task 20 – Corrosives Removal from Vitrification Slurries. GTS Duratek of Columbia, Maryland, along with British Nuclear Fuels Ltd. (BNFL), has been contracted to implement a vitrification system for immobilization of tank waste at the Hanford Site. However, sulfate and chloride in the tank waste can damage the vitrifier electrode and components of the vitrifier emission control system. These corrosives cannot be removed from the tank waste using commercial separation technologies, such as standard ion exchange or membrane filtration, because of the presence of up to 10 molar concentrations of sodium hydroxide along with significant levels of nitrate, nitrite, and other anions.

Since 1998, the EERC has been working in partnership with GTS Duratek to develop an ion-specific process to remove corrosives from radioactive and hazardous wastes. Future work will focus on optimizing the process for integration into the commercial high-level tank waste remediation system at the Hanford site.

Task 23 – Thermochemical Modeling of Volatile Hazardous Metal Behavior. Vortec Corporation of Collegeville, Pennsylvania, is responsible for the design and initial operation of a facility to vitrify wastes from the Paducah Gaseous Diffusion Plant in Paducah, Kentucky. The prevention of downstream deposition of metallic components is required for safe and efficiant flue gas handling and cleaning system performance.

To date, the EERC has provided options for mass balance and system performance sampling and analysis and has undertaken computer modeling of chemical equilibria (e.g., vaporization and condensation of hazardous metals) using a thermochemical equilibria code suited to the complex thermal system of the Vortec facility.

Task 24 – Development of an in Situ Instrument for Measuring Mercury in a Gas Stream. Sensor Research and Development Corporation (SRDC) of Orono, Maine, is developing an innovative continuous emission monitor (CEM) for mercury vapor. The goal is a simple, solid-state, low-cost, portable instrument that functions in a variety of gas environments, including combustion gas streams. The CEM, which is based on microwave technology, utilizes a thin gold film to selectively adsorb mercury. The mercury concentration measurement is obtained by comparing the character of acoustic waves traversing the gold film to the character of waves traversing a control.

The EERC is aiding SDRC by
1) incorporating the mercury CEM requirements of end users into the instrument design;
2) undertaking proof-of-concept testing at the bench- and pilot-scale levels; and 3) identifying potential demonstration sites.

IV. Summary

Under an EM Cooperative Agreement with FETC, the EERC has instituted “hands-on” focused technical support, partnership brokering, and field demonstrations that provide a vehicle for rapid commercialization and deployment. The EERC plays a vital role in this process through its technical expertise, state-of-the-art facilities, growing family of government and commercial partners, and access to field demonstration sites. The search for additional candidate technologies and commercial partners is ongoing.

V. Acknowledgments

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